Effect of Harvest Period on Senescence and Grain Yield in Some Varieties of Cowpea (*Vigna Unguiculata* (L.) Walp)

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Abstract: Studies were conducted in the rainy and dry seasons of 2009 at the International Institute of Tropical Agriculture (IITA), Kano research station - Nigeria on four cowpea varieties namely: Kanannado, IT89KD-288, IT99K-82-2 and IT99K-1060 to assess the effect of different harvesting period on senescence and grain yield. Three harvesting periods - depodding at physiological maturity, deseeding at physiological maturity and depodding at agronomical maturity were adopted for this study. Data obtained on the progression of senescence showed significant difference among the different treatments. Senescence occur very late in all varieties given physiological maturity harvest treatment and greater yield was observed by delaying these varieties of cowpea to senesce. Average number of days to total death of plants in "Kanannado" harvested at physiological maturity was observed to be 138.83 days during the rainy season, while it was 124.67days in the same variety harvested at agronomical maturity. The mean number of pods was observed to be 13.20 in "Kanannado" harvested at physiological maturity which is greater than 6.83 observed in the same variety harvested at agronomical maturity during same season.
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1. Introduction

Cowpea [*Vigna unguiculata* (L.) Walp] is an important grain legume to millions of people living in the savannah regions of the tropical and subtropical Africa. It has the ability to fix atmospheric nitrogen which allows it to grow on soils that are deficient in plant nutrient. Cowpea is one of the principal food crops cultivated in the region and its importance is mainly attributed to the high protein content in its edible parts. According to Singh, (1997), Cowpea grain contains about 23 - 25% protein. This makes valuable in situation where people cannot afford other protein foods such as meat and fish. One understated physiological processe in which the reproductive activity of cowpea [*Vigna unguiculata* (L.) Walp] can be characterized is senescence, usually viewed as an internally programmed process that occurs in many different tissues and serves different purposes. Senescence is one of the causes of low yield in cowpea due to the photoperiodic effect, this is because the local varieties are short day plants and flowering is early in the dry season (Mukhtar, 2007) which leads to early death of the plants. Most cowpea plants die after producing the first flush of pods and this is most drastic in local cultivars which are photoperiod-sensitive (Ismail and Hall, 1998).

Senescence has been well authenticated and studied experimentally in cowpea by several workers including (Abdelbagi, et al., 2000). Workers on plant senescence had been determining the extent of senescence by visually examining the degree of chlorophyll loss (leaf yellowing) which gives an idea on the extent of actual cell death. In grain legumes, the extent of leaf senescence during podding varies among genotypes and may also be modified by sink reduction (Owen et al., 2007). Reproductive activity in cowpea [*Vigna unguiculata* (L.) Walp] is characterized by two separate flushes of pod production but many plants die after producing the first flush of pods. It was also observed by Ismail and Hall, (1998), that the second flush yields in cowpea is relative to the number of plants that survive to produce the second flush.

It is therefore necessary to adequately understand the phenomenon of senescence in cowpea so as to enable crop scientists develop strategies required to overcome its effect thereby increasing yield which will be of tremendous benefit especially in the cultivation of photoperiod-sensitive cowpeas during the dry season. This study was therefore, carried out to determine the effect of time of harvest on reproductive life span of the cowpea varieties with respect to onset and duration of senescence and yield.

2.0. Materials and Methods

2.1. Study material and experimental design

Seeds of four cowpea varieties namely "Kanannado" (local cultivar), IT89KD-288, IT90K-82-2 and IT99K-1060 (improved varieties) were obtained from the International Institute of Tropical Agriculture, Kano (located in North western Nigeria within Latitude $11^0$30' and longitude $8^0$30' E) and sown at a 2–3cm depth on prepared pots for both Rainy and Dry season trials. Pot preparation was done by mixing Sandy soil and manure of ratio 5:1 and stacked into planting pots of 250mm diameter for both experiments. The mixture was then watered and allowed for two days to saturate as recommended by nursery tending operations and establishment standard (Kano State Ministry of Environment, 2005) the experiment was laid in a Randomized Complete Block Design (RCBD) with six replications for each season to minimise error.

2.2. Agronomic practice

After Germination was observed (3 to 4 and 5 to 7 days for dry and rainy seasons trial respectively), plants were thinned to two plants per pot at two weeks after germination and were managed by daily watering (during dry season experiment only). Hand weeding was done using hand hoe on the emergence of weed so as to minimise nutrient competition. However, spraying with sherpa plus was done three times during the trial against attacking pest. This was done at bud initiation stage (at 35 -45 days after planting), beginning of pod initiation stage (50 – 60 days after planting) and at rapid pod filling stage (70 days after planting).

2.3. Data collection

Three (3) harvest treatments during the period of life cycle were adopted. (Harvest at physiological maturity, deseeding at physiological maturity and harvest at agronomic maturity). Pods sampled for physiological maturity harvest treatment were harvested from each of the cowpea varieties when they have attained physiological maturity but before they senesced and dried up. Samples for deseeding at physiological maturity harvest were extracted from the pods by dissecting one side of the pods using a scalpel. The pods were left on the plant and the seeds removed, then dried in the glass house which was estimated at eleven (11) days after pod initiation from trial experiment. Pods sampled for dry maturity harvest treatment were removed at agronomical maturity when the pods have senesced and dried which is the usual harvesting time of cowpea. Observations were also done on days to onset of senescence and days to total senescence when the leaf colour changed completely to yellow due to chlorophyll loss on the leaves. Chlorophyll content was quantified for the study using a Minolta spad 502plus meter made by Spectrum Technologies, Inc. at 3, 5, 7, 8, 9 and 11 weeks after planting.

The data recorded during the trial were statistically analysed according to Snedecor and Cochran, (1980). Least significant difference (LSD) was used to separated the means and declared significant at $p<0.05$.

3. Results and Discussion

Senescence with regards to its onset and progression was significantly affected by harvesting period in both the rainy and dry season trials, but was found to be pronounced during the rainy season. Senescence progressed at faster rate in all the varieties harvested at agronomical (dry) maturity. Thus, duration to 50% and 90% senescence was extended in varieties harvested at physiological (green) maturity and those de-seeded (Table1 and 2). It can therefore be explained that plants harvested at agronomical (dry) maturity had continued to utilize the plant nutrients from the source (leaves) thereby exhausting the essential nutrients for the second flush of pods. Whereas assimilates left in the leaves of the plants harvested at physiological (green) maturity and those de-seeded were utilized by the plants for second flush of pods. Hence, there were two harvests in those two treatments which tremendously raised the number of pods and grain yield.

There was significant difference with regards to the number of pods per plant in both rainy and dry season trials. Pod length measurements during the rainy season planting varied. Pods were longer in "Kanannado" and IT99K-82-2 given agronomical maturity harvesting treatment but in IT89KD-288, it was longer in plants de-seeded at green mature while in IT99K-1060 were longer in plants harvested at physiological maturity (Table 3). For dry season, pods harvested at physiological maturity were observed to be longer except in IT99K-1060 but shorter in varieties given agronomical maturity harvest treatment (Table 4). However, number of pods per plant was observed to be greater in all varieties harvested at physiological maturity while plants harvested at agronomical maturity were observed to produce least number of pods across all trials. Khanna-Chopra and Reddy (1988) found that regulation of leaf senescence by reducing the reproductive sink intensity suggests the involvement of senescence signal from the developing seeds to the leaf. Removing the pod at physiological maturity may allow the plants a better survival strategy, since the plant can put most of its accumulated energy and resources into seed production rather than saving some for the plant to overwinter, which would limit seed production (Lawton, et al., 1990; Nooden et al., 1997). Increased number and weight (g) of seeds observed in plants harvested at physiological maturity could be associated with the number of pods which were greater in this treatment resulting from the removal of the matured pods. Senescence was delayed in varieties given physiological maturity harvest treatment but earlier in varieties harvested at agronomic maturity. Therefore, grain yield was improved upon physiological maturity harvest and deseeding treatments in relation to the delay in progression of senescence. This improvement can be seen in both photoperiod sensitive and photoperiod insensitive varieties with greater yield in the rainy season trial.

Conclusion

Findings of this study revealed that, plants harvested at agronomical maturity had lower chlorophyll content at maturity and senesced earlier. Senescence was greatly delayed by removing green mature pods as well as seeds in cowpea, and the delay significantly improved grains production by allowing second flush of pods. This would be very valuable to farmers as one of the means to control senescence and thus, maximise cowpea grains' yield. This idea can be exploited for all varieties of cowpea during rainy or dry season of a year based on findings of this trial.

Table 1. Effect of Harvesting Treatments on the Onset and Progression of Senescence in Four Cowpea Varieties Grown in 2009 Rainy Season

Variety	Treatment	Days to 50% Senescence	Days to 90% Senescence	Days to Total Death of Plant
A. Kanannado				
	P.M.H	114.50	138.83	138.83
	A.M.H	109.17	121.00	124.67
	D.S.H	113.17	131.50	135.67
	Mean	112.28	129.11	133.06
	LSD	1.88	3.03	3.07
B. T89KD-288				
	P.M.H	114.00	134.00	138.83
	A.M.H	108.17	118.33	121.83
	D.S.H	115.00	134.33	139.33
	Mean	112.39	128.89	133.33
	LSD	2.16	3.41	3.56
C. IT99K-82-2				
	P.M.H	74.50	96.83	100.17
	A.M.H	65.83	75.83	78.00
	D.S.H	69.17	92.83	95.67
	Mean	69.83	88.50	91.28
	LSD			
D. IT99K-1060				
	P.M.H	70.17	95.67	98.33
	A.M.H	64.33	72.50	75.50
	D.S.H	70.33	91.17	94.33
	Mean	68.28	86.45	89.39
	LSD	2.08	3.95	3.93

P.M.H= Physiological Maturity Harvest, A.M.H= Agronomical Maturity Harvest, D.S.H=De-Seeding Harvest, LSD=Least Significant Differences $p<0.05$.

Table 2. Effect of Harvesting Treatments on the Onset and Progression of Senescence in Four Cowpea Varieties Grown in 2009 Dry Season

Variety	Treatment	Days to 50% Senescence	Days to 90% Senescence	Days to Total Death of Plant
A. Kanannado				
	P.M.H	73.17	83.00	87.50
	A.M.H	69.33	75.33	79.83
	D.S.H	72.67	83.67	87.50
	Mean	71.72	80.67	84.94
	LSD	1.63	2.43	2.37
B. T89KD-288				
	P.M.H	74.17	83.67	88.00
	A.M.H	70.67	76.17	81.67
	D.S.H	74.00	82.83	87.17
	Mean	72.95	80.89	85.61
	LSD	1.58	2.28	2.09
C. IT99K-82-2				
	P.M.H	79.00	87.00	91.17
	A.M.H	76.67	81.33	85.50
	D.S.H	80.00	88.17	91.33
	Mean	78.56	85.50	89.33
	LSD	1.47	2.16	2.05
D. IT99K-1060				
	P.M.H	71.17	80.67	85.17
	A.M.H	68.33	73.17	78.17
	D.S.H	72.50	81.00	86.83
	Mean	70.67	78.28	83.39
	LSD	1.64	2.37	2.42

P.M.H= Physiological Maturity Harvest, A.M.H= Agronomical Maturity Harvest, D.S.H=De-Seeding Harvest, LSD=Least Significant Differences.

Table 3. Effect of Harvesting Treatments on Yield Attributes of Four Cowpea Varieties Grown in 2009 Rainy Season

Variety	Treatment	No. of Pods/Plant	Pod Length (cm)	Seed Weight/Pod (g)	100 Seed Weight (g)	Dry Matter Content (g)
A. Kanannado						
	P.M.H	13.67	11.38	9.83	15.10	44.22
	A.M.H	6.83	12.47	6.35	16.20	38.67
	D.S.H	13.17	11.73	9.36	14.10	39.88
	Mean	11.22	11.86	8.51	15.13	40.92
	LSD	2.20	0.84	1.55	1.15	1.93
B. T89KD-288						
	P.M.H	13.83	12.02	9.83	14.10	36.10
	A.M.H	7.67	11.97	6.18	15.20	42.37
	D.S.H	13.50	12.18	10.00	15.10	43.28
	Mean	11.67	12.06	8.67	14.80	40.58
	LSD	2.20	1.97	1.66	0.88	2.23
C. IT99K-82-2						
	P.M.H	8.83	10.83	5.78	12.02	15.18
	A.M.H	3.17	12.13	2.57	14.05	17.10
	D.S.H	5.67	11.53	4.76	12.02	18.63
	Mean	5.89	11.50	4.37	12.70	16.97
	LSD	1.90	0.91	1.44	1.22	1.48
D. IT99K-1060						
	P.M.H	12.17	10.87	7.06	11.02	14.28
	A.M.H	4.50	10.75	3.18	12.06	12.40
	D.S.H	8.50	10.83	6.24	13.03	14.00
	Mean	8.39	10.82	5.49	12.04	13.56
	LSD	2.21	0.42	1.61	1.13	1.13

P.M.H= Physiological Maturity Harvest, A.M.H= Agronomical Maturity Harvest, D.S.H=De-Seeding Harvest, LSD=Least Significant Differences.

Table 4. Effect of Harvesting Treatments on Yield Attributes of Four Cowpea Varieties Grown in 2009 Dry Season

Variety	Treatment	No. of Pods/Plant	Pod Length (cm)	Seed Weight/Pod (g)	100 Seed Weight (g)	Dry Matter Content (g)
A. Kanannado						
	P.M.H	5.33	9.80	3.26	13.80	14.90
	A.M.H	3.50	8.93	3.48	213.60	11.30
	D.S.H	4.33	8.98	3.77	14.30	15.00
	Mean	4.39	9.24	3.50	13.90	13.73
	LSD	1.07	0.79	0.01	1.81	1.64
B. T89KD-288						
	P.M.H	3.83	11.83	3.55	15.00	20.10
	A.M.H	2.83	10.58	2.85	14.00	22.10
	D.S.H	4.00	10.73	3.07	13.50	20.80
	Mean	3.55	11.05	3.16	14.17	21.00
	LSD	0.89	0.93	0.67	0.98	1.14
C. IT99K-82-2						
	P.M.H	4.33	10.98	3.25	14.90	22.60
	A.M.H	3.00	10.17	2.82	14.40	13.00
	D.S.H	4.33	10.47	3.03	14.60	11.80
	Mean	3.89	10.54	3.03	14.63	15.80
	LSD	0.99	0.72	0.09	0.11	2.74
D. IT99K-1060						
	P.M.H	4.50	9.75	3.24	13.80	14.90
	A.M.H	3.50	9.53	2.71	13.60	11.30
	D.S.H	3.50	10.02	3.50	13.90	15.00
	Mean	3.83	9.77	3.15	13.77	13.73
	LSD	0.83	0.33	0.72	0.40	1.64

P.M.H= Physiological Maturity Harvest, A.M.H= Agronomical Maturity Harvest, D.S.H=De-Seeding Harvest, LSD= Least Significance Differences.

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